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Original Translation

Description

Optical coupling device

The invention relates to an optical coupling device for cross-coupling light from a first optical waveguide into a second optical waveguide. Such a coupling device is known, for example, from WO 98/13718.

Such coupling devices are used in optical filters according to the phased-array principle with an injection face which light enters at a specific geometrical position, the geometrical position influencing the output wavelength of the optical filter. Such optical filters according to the phase-array principle are used, in particular, as multiplexers or demultiplexers in optical wavelength-multiplex operation (WDM), since they exhibit low insertion attenuation and high crosstalk suppression. The optical filter has, as its essential component, a plurality of curved optical waveguides of different length, which form a phase-shifter region. German Patent Application DE 44 22 651.9 describes that the central wavelength of a phased-array filter can be established through the position of an injection optical waveguide, which guides the light into the layer waveguide. In this way, the central wavelength of the optical filter can be adjusted accurately through the geometrical positioning of the injection optical waveguide or the injection fibre. Since it is therefore desirable for the optical waveguides to be shifted relative to one another, the optical waveguides cannot be adhesively bonded directly to one another.

In known coupling devices, the fibres are adhesively bonded into V grooves and it cavities which are produced in the process are filled with adhesive. Since

the adhesive exhibits a different behaviour with respect to temperature, expansion coeffecient, water absorption, etc. from that of the fibres and holding blocks or the variable-length element, stresses may occur in the adhesive under changing environmental conditions, and therefore deadjustment of the fibres.

The object of the invention is to provide an optical coupling device in which the connection between two optical wave guiding structures, in particular the connection between an optical waveguide (optical fibre/optical ribbon) and a strip conductor of an optical component (chip) is achieved with high reliability and stability and cost-effective mounting. This object is achieved by an optical coupling device having the features specified in Patent Claim 1.

One advantageous configuration of the coupling device according to the invention is characterized in that the ferrule is inserted into a hole in the variable-length element.

In the coupling device cited in the introduction, the first holding block is fixed to the chip and the optical waveguide fibre is held on the variable-length element. In this case, the variable-length element may oscillate or bend, which causes temporary or permanent deadjustment of the fibre.

For this purpose, one advantageous configuration of the optical coupling device according to the invention is characterized in that the guide device has a second holding block as an abutment, on which the variable-length element is guided in the direction of its main extension direction. In this way, improved guidance of the variable-length element parallel to the coupling face is ensured, and additional effort is avoided.

This arrangement permits the variation in length of the variable-length element, but restricts the movement of the element in the abutment only in the dimension perpendicular to the extension direction of the variable-length element. In this case, the guidance of the moveable axis is very accurate, so that any movements in the direction of the fixed axis are less than one micrometre. This means that the movement of the first optical waveguide (fibre) relative to the second optical waveguide (chip) takes place very exactly parallel to the surface of the chip, and that deadjustment in other dimensions virtually does not occur.

A further advantageous configuration of the device according to the invention is characterized in that the guide device has a ferrule which is connected to the variable-length element and which is mounted in a hole in the second holding block such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place. In this case, it is advantageous if the ferrule is guided in a suitable, commercially available coupling sleeve in the second holding block, which serves as an abutment.

A further advantageous configuration of the device according to the invention is characterized in that the guide device has a ferrule which is connected to the second holding block and which is mounted in a hole in the variable-length element such that it can be displaced in the direction of the axis of the variable-length element in which the variation in length takes place. In this, it is advantageous if the ferrule is guided in the variable-length element by a sleeve.

In particular by using a ferrule, for example a commercially available optical waveguide plug ferrule,

which is fitted in the longitudinal direction of the variable-length element, particularly accurate guidance can be achieved.

A further advantageous configuration of the device according to the invention is characterized in that the guide device is formed by a tongue and groove connection between the variable-length element and the second holding block. This provides a guide device which is mechanically simple to implement, without having to make recourse to additional components.

A further advantageous configuration of the device according to the invention is characterized in that the second holding block has a U-shaped cross section, and in that the variable-length element is guided in the U-shaped cross section of the second holding block. In this case, the result is guide surfaces, on both sides of the variable-length element, which ensure appropriately accurate guidance. This provides an optical coupling device in which the optical connection between an optical waveguide fibre and an optical chip is achieved with high security and stability with cost-effective mounting.

A further advantageous configuration of the device according to the invention is characterized in that an abutment is fixed to the variable-length element, acting on the second optical waveguide in a displaceable manner, the abutment advantageously having, on one side, a spring between one end of the abutment and the second waveguide and, on the other side, a setting screw between another end of the abutment and the second optical waveguide. The abutment fitted to the variable-length element can slide along on the second optical waveguide. By means of the screw, the pressure and the position perpendicular to the surface of the second optical waveguide can be adjusted.

Exemplary embodiments of the invention will be explained below using the drawings, in which:

Fig. 1 shows the schematic construction of the connection between the variable-length element and an optical waveguide fibre;

Fig. 2 shows a side view of the device according to Fig. 1; and

Fig. 3 shows an optical waveguide fibre array to be coupled to optical chips, with many parallel optical waveguides,

Figs 4A and 4B show a side view and, respectively, an end view of a coupling device according to an exemplary embodiment of the invention;

Figs 5A and 5B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention;

Figs 6A and 6B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention;

Figs 7A and 7B show a side view and, respectively, an end view of a further exemplary embodiment of the coupling device according to the invention.

A rectangular, elongate, variable-length element 2, consisting of aluminium, for example, is illustrated in end view in Fig. 1 and in side view in Fig. 2. The variable-length element 2 is fixed to a holding block 4, produced from glass or a glass ceramic, for example, adhesively bonded to the surface of an optical chip (not shown). The element 2 is connected to the holding block 4, likewise at one end.

A commercially available ferrule 6 held in an appropriate hole 8 is fixed in the element 2. An optical fibre 10 is fixed in the ferrule 6. The ferrule 8 can either be installed perpendicularly into the element 2 or at an angle of, for example, 82° to 83°,

in order to reduce reflections at the end face of the fibres. The ferrule can also be a multi-fibre ferrule.

Fig. 3 shows a group of fibres in a block 12, the fibres 10 in each case being arranged in a ferrule 6, which are in turn fitted or bonded into corresponding holes 8 in the block 12.

Fig. 4A shows a fibre 20 as a first optical waveguide, which is fixed in a variable-length element 26 via a ferrule 24. The variable-length element 26 is fixed or adhesively bonded to a holding block 28, which in turn is fixed, in particular likewise adhesively bonded, to a second optical waveguide 30, an optical waveguide chip in this example.

At the free end 32 of the variable-length element 26, a ferrule 36 is arranged in a corresponding hole 34, the ferrule 36 projecting beyond the free end face 32 of the variable-length element 26. The free end of the ferrule 36 is mounted via a guide sleeve 38 in a second holding block 40, so that the variable-length element 26 can extend substantially only in the direction of its longitudinal axis, but on the other hand cannot move in the directions orthogonal thereto. Since the ferrule 36 and the sleeve 38 are tried and tested standard components, secure guidance of the variable-length element 26 in the direction of its longitudinal axis is ensured. Alternatively, the ferrule 36 can be arranged firmly in the holding block 40 and mounted so as to slide in the variable-length element 26.

In Fig. 5A, a fibre 42 is shown as the first optical waveguide, which is fixed in a variable-length element 46 via a ferrule 44. The variable-length element 46 is fixed or adhesively bonded to a holding block 48 which, in turn, is fixed or adhesively bonded to a second

optical waveguide 50, an optical waveguide chip in this example.

Provided in one end 52 of the variable-length element 46 is a groove 54, which acts on a corresponding tongue 56 on a second holding block 58, and therefore forms a tongue and groove connection between the variable-length element 46 and the second holding block 58.

In Fig. 6A, a fibre 62 is shown as the first optical fibre, which is fixed in a variable-length element 66 via a ferrule 64. The variable-length element 66 is fixed or adhesively bonded to a holding block 68 which, in turn, is fixed or adhesively bonded to a second optical waveguide 70, an optical waveguide chip in this example.

At its free end 72, the variable-length element 66 is mounted on a holding block 74 with a U-shaped cross section, the variable-length element 66 being guided in the U-shaped cross section of the holding block 74. With its two legs 76, 78, the holding block 74 therefore engages around the front end 72 of the variable-length element 66, so that the latter is likewise satisfactorily guided.

In Fig. 7A, a fibre 82 is shown as the first optical waveguide, which is fixed in a variable-length element 86 via a ferrule 84. The variable-length element 86 is fixed or adhesively bonded to a holding block 88 which, in turn, is fixed or adhesively bonded to a second optical waveguide 90, an optical waveguide chip in this example.

Fixed to the end of the variable-length element is an abutment 92, which engages on the second optical waveguide 90 in a displaceable manner. As can be seen from Fig. 7B, the abutment 92 has a U-shaped cross

section and is supported by one leg 94, via a spring 96, on one side of the second optical waveguide 90 and, on the other side, via a setting screw 100 arranged on the other leg 98 of the abutment 92, on the second optical waveguide. By means of the setting screw 100, the pressure and therefore the position of the variable-length element 86 can be adjusted.